

HETA 93-0028-2366
NOVEMBER 1993
WEST HELENA - HELENA SPORTSWEAR, INC.
WEST HELENA, ARKANSAS

NIOSH Investigator:
Alan Echt, MPH, CIH

I. Summary

In October 1992, the National Institute for Occupational Safety and Health (NIOSH) received an employee request for a health hazard evaluation (HHE) concerning adverse health effects resulting from exposure to formaldehyde during the manufacture of garments at West Helena - Helena Sportswear, Inc. in West Helena, Arkansas. On March 22-23, 1993, NIOSH investigators conducted a walk-through inspection of West Helena - Helena Sportswear and collected personal breathing zone (PBZ) and general area (GA) samples for formaldehyde, total particulate, and formaldehyde on inhalable dust.

Eight PBZ samples for formaldehyde were collected for employees sewing linings, cutting cloth, and bundling cloth. Eight-hour time-weighted average (TWA) PBZ concentrations of formaldehyde ranged from 0.14 to 0.17 ppm. The results of eight PBZ samples for formaldehyde on inhalable dust collected on the same employees ranged from less than the limit of detection to 29 µg/mg. Eleven GA samples for formaldehyde and total particulate were collected in various locations in the facility. Formaldehyde concentrations measured in GA samples ranged from 0.16 to 0.25 ppm, 8-hour TWA. Total particulate concentrations in GA samples ranged from 0.02 to 0.15 mg/m³, 8-hour TWA. Four samples were collected outside of the plant, one according to each of the four sampling methods. Results of these four samples were <0.009 ppm of formaldehyde utilizing the PBZ sampling method, 0.01 ppm of formaldehyde, 8-hour TWA, utilizing the GA sampling method, 0.04 mg/m³ of total particulate, and equal to the limit of detection of the method for formaldehyde on inhalable dust.

Personal breathing zone and GA samples for formaldehyde exceeded the NIOSH Recommended Exposure Limit (REL) of lowest feasible concentration. These results were less than the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) and action level of 0.75 and 0.5 ppm, 8-hour TWA respectively, but exceeded the OSHA threshold of 0.1 ppm for mandatory employee training and other provisions of the hazard communication section of the OSHA formaldehyde standard. These results were less than the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Value (TLV) of 0.3 ppm of formaldehyde, as a ceiling concentration. Results of samples for total particulate were less than the nuisance dust evaluation criteria; however, since the dust was found to contain formaldehyde this criteria may not be protective enough. There are no occupational exposure limits for formaldehyde on inhalable dust.

Formaldehyde concentrations measured in this facility exceeded the NIOSH recommendation to reduce exposures to the lowest feasible concentration, and the OSHA threshold of 0.1 ppm for mandatory employee training and other provisions of the hazard communication section of the OSHA formaldehyde standard. Recommendations for controlling the formaldehyde exposures, as well as potential exposures to other contaminants noted during the evaluation are presented in section VIII of this report.

Keywords: SIC 2337 (Women's, Misses', and Juniors' Suits, Skirts, and Coats),
Formaldehyde, Garment Workers

II. Introduction

On October 27, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request from a group of employees for a health hazard evaluation (HHE) at West Helena - Helena Sportswear, Inc. in West Helena, Arkansas. The request concerned health effects, including cancer and lung disease, which the requestors attributed to formaldehyde exposure in the workplace. NIOSH investigators conducted the HHE on March 22-23, 1993. Two representatives of the Arkansas Department of Health accompanied the NIOSH investigators on the second day of this evaluation.

III. Background

West Helena - Helena Sportswear manufactures ladies' sportswear. Pre-cured permanent-press fabrics received from various suppliers are spread on large tables and then cut according to the garment pattern. Cut pieces are fused (fusing bonds a lining to the garment), bundled, and have bar tags sewn on to the piece. The cut pieces are then sewn to assemble the garment. Finally, the assembled garment is pressed, inspected, bagged, and shipped. Some spot cleaning is performed with 1,1,1 - trichloroethane during final inspection. Approximately 1,000 finished garments are produced each day. Clothing made of rayon-blends was being manufactured on the day of the NIOSH evaluation. The entire facility is air conditioned, and the pressing department is also equipped with roof-top ventilators. According to the plant engineer, the air conditioning system does not provide any outdoor air to the plant. Smoking is permitted in the front office and in the cafeteria.

Prior to the HHE, formaldehyde exposures at West Helena - Helena Sportswear were evaluated by the Arkansas Department of Labor, the Occupational Safety and Health Administration of the U.S. Department of Labor (OSHA), the International Ladies' Garment Workers' Union, and the company's insurance carrier.

An industrial hygienist from the Arkansas Department of Labor OSHA Consultation Service visited the facility on July 28, 1992. The report of that visit noted that employees were wearing unapproved respirators, that there was no written respiratory protection program, and that the company had not developed a written hazard communication program. The report also contains the results of air sampling performed for formaldehyde. The results for four samples range from <0.04 parts per million of formaldehyde in air (ppm) to 0.10 ppm (one sample). Sampling times range from 72 to 100 minutes. The report contains seven recommendations to address complaints by a few employees in the sewing department of upper respiratory tract irritation, headaches, and eye irritation.

The OSHA compliance inspection, which was conducted on October 19, 1992, resulted in citations for an unmarked exit and for not developing or implementing a hazard communication program. The company provided the NIOSH investigators with a copy of the results of air sampling performed by the OSHA compliance officer. The result of the one 16-minute sample collected was less than the limit of detection for the method.

The company provided the results of the sampling conducted by the union. These results indicate that one sample was collected for four hours using a passive sampler on August 15, 1992. This sample indicated that the employee who wore the monitor was exposed to formaldehyde below the limit of detection of the sampler (<0.04 ppm).

Finally, representatives of West Helena - Helena Sportswear's loss control insurance carrier visited the plant on October 29, 1992. Their report states that because numerous air samples had previously been collected, and since the fabrics of concern (their report

identifies these as 1206 Jet Black and 1206 Dark Olive) were not being used at the time of their site visit, the insurance carrier's evaluation focused on work practices, control measures, and the results of previous sampling. They concluded that formaldehyde exposures at concentrations measured by the union and the Arkansas Department of Labor would not pose a hazard to the majority of workers. They recommended that the company implement the recommendations in the report from the Arkansas Department of Labor, and that the company obtain Material Safety Data Sheets (MSDS) for fabrics from one of the suppliers to determine the cause of employee complaints.

IV. Evaluation Methods

On March 22, 1993, the NIOSH industrial hygienists performed a walk-through inspection of the facility to become familiar with the facility and the manufacturing process. On March 23, 1993, eight full-shift personal breathing zone (PBZ) samples for formaldehyde were collected and analyzed in accordance with NIOSH Method 2541 with modifications.¹ Samples were collected on SKC lot 853 solid sorbent tubes (10% 2-[hydroxymethyl] piperidine on XAD-2 resin) in plastic holders connected via a length of Tygon tubing to battery-powered personal sampling pumps operating at a flow rate of 100 milliliters per minute (mL/min). In order to collect PBZ samples representative of potential formaldehyde exposures for cutters and bundlers, the pumps were attached to a belt at the employee's waist, while the sorbent tube holder was attached to the employee's lapel. Since employees in the liner department are seated while they sew garments, the sampling pumps were attached to the back of the employee's chair, while the sorbent tube holder was attached to the employee's lapel. One sample was collected outside the facility as well. Pumps used to collect PBZ samples were turned off during the lunch break. The analytical limit of detection (LOD) for this sample set was 0.4 micrograms (μg)/sample, which equates to a minimum detectable concentration (MDC) of 0.008 ppm, based upon the maximum air sampling volume for this set of samples, 38.3 L. The limit of quantitation (LOQ) for this sample set was 1.3 μg /sample, which equates to a minimum quantifiable concentration (MQC) of 0.028 ppm, based upon a maximum sample volume of 38.3 L.

Twelve GA samples for formaldehyde were collected and analyzed in accordance with NIOSH Method 3500.¹ One of the samples was collected outside the plant. Samples were collected with midget impingers containing approximately 15 mL of 1% sodium bisulfite solution. Each impinger was preceded by a tared 37-millimeter (mm) diameter, 5-micrometer (μm) pore-size polyvinyl chloride (PVC) filter in order to exclude formaldehyde-containing particulate from the impinger, and thus prevent a positive bias. Tygon tubing was used to connect the filter cassette to the impinger, and to connect the impinger to a battery-powered sampling pump calibrated at a flow rate of 1 liter per minute (L/min). The analytical LOD for this set of samples was 2 μg /sample, which equates to a MDC of 0.004 ppm, based upon the maximum sample volume for this set of samples, 439 L. The MQC for this sample set was 0.007 ppm, based upon an analytical LOQ of 3.9 μg /sample, and a maximum sample volume of 439 L.

In order to assess the degree of total particulate (e.g., dust, lint) exposure, the PVC filters were analyzed according to NIOSH Method 0500 with modifications.¹ These modifications included 1) the backup pads were not desiccated; and 2) the filters were stored in an environmentally controlled room (21 ± 3 °C and $50 \pm 5\%$ Relative Humidity), and subjected to the room conditions for at least several days duration for stabilization. This reduces the method's 8 to 16-hour time for stabilization between tare weighings to 5 to 10 minutes. The limit of detection of this method, 0.02 milligrams, is determined by the precision of the balance used to weigh the filters.

Eight PBZ samples for formaldehyde on dust were collected as well. As with the PBZ samples for formaldehyde, employees in the cutting and bundling areas wore sampling pumps on belts at their waist, with the sampling device attached to their lapels. Employees sewing garments wore the sampling device with the sampling pumps attached to the back of their chairs. A sample was collected outside the facility as well. Samples were collected on tared 25-mm diameter, 5 μm pore size PVC filters placed in personal samplers for inhalable dust. These samplers collect inhalable (inspirable) particles in the size range which represents the dust the worker takes in through the nose and mouth during the act of breathing, i.e., particles with an aerodynamic diameter up to 100 μm .^{2,3} Inhalable particles have been described as those that can be deposited anywhere in the respiratory tract.³ The samplers were connected via Tygon tubing to battery-powered sampling pumps operating at a flow rate of 2 L/min. Samples collected in this manner were analyzed using both NIOSH Method 5700 and the analysis procedure from the National Council of Air and Stream Institute (NCASI) method, Formaldehyde in Water Leachates of Paper and Wood Dust Particles.^{1,4} Two bulk samples of settled dust (lint) were analyzed according to these methods as well. The LOD for the NIOSH method for this sample set was 0.5 $\mu\text{g}/\text{sample}$, or a MDC of 0.6 $\mu\text{g}/\text{m}^3$ for a sample volume of 815 L, the maximum sample volume for this set of samples. The MQC for the NIOSH method for this sample set was 1.8 $\mu\text{g}/\text{m}^3$, based upon a LOQ of 1.5 $\mu\text{g}/\text{sample}$ and a sample volume of 815 L. For the NCASI analysis, the LOD was 0.4 $\mu\text{g}/\text{sample}$, and the LOQ was 1.4 $\mu\text{g}/\text{sample}$. Based upon the maximum sample volume of 815 L, the MDC was 0.5 $\mu\text{g}/\text{m}^3$, and the MQC was 1.7 $\mu\text{g}/\text{m}^3$.

V. Evaluation Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed from eight to ten hours a day, forty hours a week, for a working lifetime without experiencing adverse health effects. However, it is important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled to the level set by the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, thus potentially increasing the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), 2) OSHA Permissible Exposure Limits (PELs), and 3) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs).^{5,6,3} The OSHA PELs may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; in contrast, the NIOSH-RELs are primarily based upon the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing those levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA PEL.

A time-weighted average exposure level (TWA) refers to the average airborne concentration of a substance during a normal eight to ten hour workday. Some substances have recommended short-term exposure limits (STELs) or ceiling values which are

intended to supplement the TWA where there are recognized toxic effects from brief high exposures.

Formaldehyde

Formaldehyde (CAS number 50-00-0) is a colorless gas with a pungent and irritating odor at ambient temperatures;⁷ its odor threshold is approximately 0.8 ppm.^{7,8} Formaldehyde may cause adverse health effects following exposure via inhalation, ingestion, or dermal or eye contact.⁷ Mild eye irritation with tearing and other transient symptoms of mucous membrane irritation have been observed in some persons at concentrations of 0.1 to 0.3 ppm.⁹ For most people, however, a tingling sensation in the eyes, nose, and the back of the throat is not experienced until concentrations reach 2 to 3 ppm.⁹ Mild to unpleasant eye irritation occurs in acclimated workers at 2 to 10 ppm, and intolerable irritation (tissue damage possible) occurs at levels above 25 ppm.⁷ A number of studies suggest that formaldehyde causes asthma and/or exacerbates preexisting respiratory conditions.⁹

Formaldehyde is one of the most common causes of skin disease in the workplace.⁹ The major effects of formaldehyde on the skin are irritant dermatitis and allergic contact dermatitis.⁹ Irritant dermatitis is the result of direct injury to the skin and is characterized by redness and thickening of the affected areas. Skin sensitization to formaldehyde is well known.⁹ For sensitized individuals, repeated contact tends to cause more severe reactions, and sensitization usually persists for life.⁹

Based upon the results of laboratory tests which have demonstrated the carcinogenic and mutagenic activity of formaldehyde in animals, NIOSH and OSHA recommend that formaldehyde be handled in the workplace as a potential occupational carcinogen.^{10,11} NIOSH recommends that occupational exposures to formaldehyde be controlled to the lowest feasible limit.⁵ On December 4, 1987, OSHA issued a comprehensive regulation covering occupational exposure to formaldehyde (29 CFR 1910.1048). This rule reduced the 8-hour TWA PEL to 1 ppm and established a 2 ppm 15-minute STEL. The comprehensive standard also included an "action level" of 0.5 ppm, measured as an 8-hour TWA, and provisions for employee exposure monitoring, medical surveillance, recordkeeping, regulated areas, emergency procedures, preferred methods to control exposure, maintenance and selection of personal protective equipment, and hazard communication. OSHA's rule was based on the consideration of a wide range of new evidence including animal bioassays and epidemiological evidence. It was based in part on OSHA's recognition of formaldehyde as a potential occupational carcinogen as well as its irritating and sensitizing effects.¹⁰

On May 27, 1992, OSHA amended its existing regulation for occupational exposure to formaldehyde to take effect on June 26, 1992. The final amendments lowered the 8-hour PEL for formaldehyde from 1 ppm to an 8-hour TWA of 0.75 ppm. The amendments also added medical removal protection provisions to supplement the existing medical surveillance requirements for those employees suffering significant eye, nose, or throat irritation; and for those suffering from dermal irritation or sensitization from occupational exposure to formaldehyde. Additional hazard labeling, including a warning that formaldehyde presents a potential cancer hazard, is required where formaldehyde levels, under reasonably foreseeable conditions of use, may potentially exceed 0.5 ppm. The final amendments also provided for annual training of all employees exposed to formaldehyde at levels of 0.1 ppm or higher.¹⁰

ACGIH classifies formaldehyde as a Suspected Human Carcinogen (i.e., a chemical substance associated with industrial processes, which are suspect of inducing cancer, based on either limited epidemiological evidence or demonstration of carcinogenesis in one or more animal species by appropriate methods).³ The recommendation of ACGIH concerning a Suspected Human Carcinogen is that worker exposures by all routes be carefully controlled to levels as low as reasonably achievable below its TLV.³ On June 2, 1992, ACGIH adopted a ceiling limit TLV of 0.3 ppm. A ceiling limit is a concentration that should not be exceeded during any part of the working exposure. ACGIH formerly recommended an 8-hour TLV-TWA of 1 ppm and a 15-minute STEL of 2 ppm for formaldehyde. The revised TLV was adopted to further reduce sensory irritation for workers handling formaldehyde or formaldehyde-containing products. Moreover, ACGIH stated that because the reported dose-dependent carcinogenic effect in the rat and mouse and the inadequate epidemiologic data on the cancer risk in man, it was advisable to reduce formaldehyde workplace exposure to the lowest possible level.¹²

Total Particulates

Total particulates (nuisance dusts) have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under

reasonable control. The lung tissue reaction caused by inhalation of nuisance dusts has the following characteristics: 1) the architecture of the air spaces remains intact; 2) scar tissue is not formed to a significant extent; and 3) the tissue reaction is potentially reversible.³

The current OSHA PEL for particulates not otherwise regulated is 15 mg/m³ for total dust.⁶ The ACGIH TLV for particulates not otherwise classified is 10 mg/m³ for total dust.³ These criteria were established to minimize mechanical irritation of the eyes and nasal passages, and to prevent visual interference. NIOSH has not developed specific criteria for total particulates.

Formaldehyde on Dust¹³

In two mortality studies dealing with occupational exposure to formaldehyde, a difference in results has brought into question the source of formaldehyde exposure in each study. In a study by Stayner *et al.*, in which statistically significant elevations in proportionate mortality were observed for cancers of the parotid gland, gallbladder, and multiple myeloma, formaldehyde measurements revealed low levels, assumed to be in a vapor-phase due to offgassing of formaldehyde from cloth used in garment manufacture.¹⁴ In a reanalysis of data from an earlier study, Blair *et al.* stated that "the pattern for nasopharyngeal cancer suggests that simultaneous exposure to formaldehyde and particles may be a risk factor for this tumor."¹⁵ The factories in the Stayner study and the Blair study where excess nasopharyngeal cancers were found were noted to be dusty. Therefore, the particulate matter to which employees were exposed may have contained either adsorbed or chemically-bound formaldehyde, the latter of which could be released in the warm, moist environment of the upper respiratory tract. Much work remains to be done in this area to better assess the effect of formaldehyde-containing dust on the incidence of cancers of the upper respiratory tract. There are currently no workplace evaluation criteria for formaldehyde-containing dust.

VI. Results and Discussion

The results of PBZ samples for formaldehyde are presented in Table 1. The results ranged from 0.14 to 0.17 ppm, 8-hour TWA. These results are less than the OSHA PEL and OSHA action level, as well as the ACGIH TLV. However, these results exceed the NIOSH REL of lowest feasible concentration, and exceed the 0.1 ppm level for OSHA-required annual employee training. The results of GA samples for formaldehyde are presented in Table 2. Eight-hour TWA results ranged from 0.16 to 0.25 ppm. For both sampling methods, concentrations inside the plant exceeded concentrations measured outdoors, indicating that reducing concentrations inside the plant is possible by increasing the amount of outdoor air entering the facility.

The results of samples collected for total particulate indicate that exposures in the facility do not approach the applicable evaluation criteria. These results are presented in Table 3. The highest 8-hour TWA concentration measured, 0.15 mg/m³, is 100 times less than the applicable OSHA PEL, and more than 60 times less than the ACGIH TLV. NIOSH has not developed specific criteria for total particulates.

Due to analytical problems with the analysis of formaldehyde on dust by NIOSH Method 5700, only the results of the analysis by the NCASI method are presented in this report. The results of sampling for formaldehyde on inhalable dust (Table 4) should be interpreted cautiously, as there are no occupational exposure criteria for this material. The results do indicate, however, that dust from clothing manufacturing processes in this facility does contain formaldehyde. The formaldehyde on dust measurements may not have the same

biological significance as the formaldehyde vapor measurements, as the particulate formaldehyde data may be representative of formaldehyde exposure at a point of retention in the respiratory tract, while the vapor phase measurements represent exposure to the entire respiratory tract. Furthermore, the point of retention depends upon the particle size distribution of the aerosol, which was not determined in this evaluation. Two bulk samples of settled dust contained 0.70 and 0.80 μg of formaldehyde per mg of the sampled material. The samples were collected from on top of a fluorescent light near the cutting department, and from the base of a metal column adjacent to the cutting and pocket departments, respectively.

VII. Conclusions

The concentrations of formaldehyde measured in this facility on the day of the survey exceeded the NIOSH recommendation that formaldehyde exposures be maintained at the lowest feasible concentration and, in some cases, approached the ACGIH TLV of 0.3 ppm as a ceiling limit. While measured exposures were less than the OSHA PEL and action level, they exceeded the level where OSHA mandates annual training of all exposed employees. The recommendations section of this report suggests ways to reduce potential formaldehyde exposures at West Helena - Helena Sportswear.

The fact that these results differ from the results of sampling conducted by representatives of two other government agencies and the labor union can not be explained by faulting their evaluation techniques. One possible explanation for the differences in measured exposures is that the amount of formaldehyde released from fabrics is highly variable, depending upon the treatment used, the length of time the fabric was stored, as well as other factors.

Total particulate concentrations measured in the plant were less than the nuisance dust evaluation criteria; however, since the dust was found to contain formaldehyde these criteria may not be sufficiently protective. The health effects of measurable concentrations of formaldehyde on inhalable dust are not clear. However, these results may explain employee complaints of irritating dust in a facility where total particulate exposures were so low.

VIII. Recommendations

The following recommendations may help to reduce formaldehyde exposures at West Helena - Helena Sportswear, Inc.

1. Since the levels of formaldehyde were similar on samples collected throughout the plant, the use of general dilution ventilation might be effective in reducing these exposures. One option would be modifying the air-conditioning system in order to provide conditioned outdoor air to the plant. Other options to consider would include working with the fabric suppliers to minimize the amount of free formaldehyde released from a given fabric type, or refusing delivery of particularly problematic fabric lots (i.e; those lots which have been associated with increases in employee complaints).
2. Provide personal protective equipment, such as gloves or long sleeves, to prevent skin contact with formaldehyde-treated cloth. Dermatitis in the textile and apparel industries is well documented, and formaldehyde is a well known sensitizer.⁹ The OSHA formaldehyde standard states that contact with irritating or sensitizing materials shall be prevented to the extent necessary to eliminate the hazard.¹⁰ OSHA

has interpreted this to require a two tiered approach to prevent employee contact with these materials.¹⁶

- a. When dermatitis is the result of skin sensitization from previous exposure to formaldehyde then only those employees with the skin problems need to be protected.
- b. When the skin problems are the result of irritant dermatitis then, as a minimum, all employees who do the same job as the workers with the skin problems must be protected.

If there are legitimate safety concerns in having employees wear PPE, then the employer, as a minimum, needs to have a program for identifying high risk groups and investigating outbreaks of dermatitis.¹⁶

3. Provide OSHA-mandated training for employees exposed to formaldehyde in concentrations in excess of 0.1 ppm, and implement the elements of the hazard communication portion of the formaldehyde standard. Make medical surveillance available for employees who develop signs and symptoms of overexposure to formaldehyde. The OSHA formaldehyde standard contains the provision that the employer may rely on the evidence that signs and symptoms associated with formaldehyde exposure will occur only in exceptional circumstances when airborne exposure is less than 0.1 ppm when determining whether an employee may be experiencing signs and symptoms of possible overexposure to formaldehyde.¹⁰ However, the concentrations of formaldehyde measured by the NIOSH investigators exceeded 0.1 ppm, and OSHA has determined that this section of the standard is a guideline and not an exemption.¹⁷
4. The spot-cleaning process is located in front of the return air inlet for the air-conditioning system. This process should be moved to another location. The employee performing spot-cleaning should receive training in the hazards of 1,1,1-trichloroethane, and the degree to which she is exposed should be determined. Obtain a material safety data sheet for Super Fray Free, a product used in the cutting department.
5. NIOSH recommends that workers should not be involuntarily exposed to tobacco smoke.¹⁸ Exposure to environmental tobacco smoke (ETS) may be responsible for irritant symptoms and can exacerbate allergic symptoms. Further, NIOSH has determined that ETS poses an increased risk of lung cancer and possibly heart disease to occupationally exposed workers.¹⁸ The best method for controlling worker exposure to ETS is to eliminate tobacco use from the workplace and to implement a smoking cessation program. Until tobacco use can be completely eliminated, the employer should make efforts to protect nonsmokers from ETS by isolating areas where smoking is permitted. Restricting smoking to smoking areas outside the building (away from entrances, air intakes, and operable windows) or in separate smoking areas with dedicated ventilation are two ways to accomplish this. Air from smoking areas should be exhausted directly outside and not recirculated within the building or mixed with the general dilution ventilation for the building. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommends 60 cubic feet per minute (cfm) per person of outside or transfer air be supplied to the smoking area. A negative pressure should be provided to prevent airflow back into the non-smoking workplace.^{18,19}

IX. References

1. NIOSH [1989]. Eller PM, ed. NIOSH manual of analytical methods. 3rd rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. DHHS (NIOSH) publication No. 84-100.
2. Mark D, Vincent JH [1986]. A new personal sampler for airborne total dust in workplaces. *Ann Occ Hyg* 30:89-102.
3. ACGIH [1992]. Threshold limit values and biological exposure indices for 1992-1993. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
4. Elia VJ, Messmer RA [1992]. Evaluation of methods for estimating formaldehyde released from resin-containing paper and wood product dusts. *Am Ind Hyg J* 53:632-638.
5. NIOSH [1992]. NIOSH recommendations for occupational safety and health. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control; National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.
6. Code of Federal Regulations [1992]. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.
7. NIOSH [1988]. Occupational safety and health guidelines for chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 89-104, Supplement II-OHG.
8. Amoores JE, Hautala E [1983]. Odor as an aid to chemical safety: odor thresholds compared with threshold limit values and volatilities for 214 industrial chemicals in air and water dilution. *J Appl Tox* 3:272-290.
9. Hathaway GJ, Proctor NH, Hughes JP, Fischmann ML, eds. [1991]. Proctor and Hughes' chemical hazards of the workplace. 3rd ed. New York, NY: Van Nostrand Reinhold Company, pp. 305-307.
10. 57 Fed. Reg. 22290 [1992]. Occupational Safety and Health Administration: occupational exposure to formaldehyde; final rule. (To be codified at 29 CFR 1910.1048.)
11. NIOSH/OSHA [1980]. Current intelligence bulletin 34: Formaldehyde: evidence of carcinogenicity. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 81-111.
12. ACGIH [1992]. Notice of intended change - formaldehyde. *Appl Occup Environ Hyg* 7:852-874.
13. Kennedy ER, Gagnon YT, Teass AW, Seitz T [1992]. Development and evaluation of a method to estimate potential formaldehyde dose from inhalable dust/fibers. *Appl Occup Environ Hyg* 7:231-240.
14. Stayner L, Smith AB, Reeve G, et al [1985]. Proportionate mortality study of

- workers in the garment industry exposed to formaldehyde. *Am J Ind Med* 7: 229-240.
15. Blair A, Stewart P, O'Berg M, et al [1986]. Mortality among industrial workers exposed to formaldehyde. *J Natl Cancer Inst.* 76: 1071-1084.
 16. Shepich TJ [1989]. Memorandum of February 21, 1989, from T.J. Shepich, Directorate of Compliance Programs, to Roger Clark, Regional Administrator, Occupational Safety and Health Administration, U.S. Department of Labor.
 17. Clark PK [1990]. Letter of August 8, 1990, from P.K. Clark, Director Designate, Directorate of Compliance Programs, Occupational Safety and Health Administration, U.S. Department of Labor, to Michelle Fecteau, Health and Safety Coordinator, International Ladies' Garment Workers' Union.
 18. NIOSH [1991]. Environmental tobacco smoke in the workplace: Lung cancer and other health effects. Cincinnati OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 91-108.
 19. ASHRAE [1990]. Ventilation for acceptable indoor air quality. Atlanta, GA: American Society of Heating, Refrigerating, and Air-conditioning Engineers. ANSI/ASHRAE Standard 62-1989.

X. Authorship and Acknowledgements

Report Prepared by: Alan Echt, MPH, CIH
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies

Field Assistance: Gregory A. Burr, CIH
Supervisory Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations and Field Studies

Analytical Support: DataChem Laboratories
Salt Lake City, Utah

Measurements Research and Support Branch
Division of Physical Sciences and Engineering

Methods Research Branch
Division of Physical Sciences and Engineering

Originating Office:

Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies

Report Typed By:

Kate Marlow
Office Automation Assistant

XI. Distribution and Availability of Report

Copies of this report may be freely reproduced and are not copyrighted. Single copies of this report will be available for a period of 90 days from the date of this report from the NIOSH Publications Office, 4676 Columbia Parkway, Cincinnati, Ohio 45226. To expedite your request, include a self-addressed mailing label along with your written request. After this time, copies may be purchased from the National Technical Information Service, 5285 Port Royal Rd., Springfield, Virginia 22161. Information regarding the NTIS stock number may be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Office Manager, West Helena - Helena Sportswear
2. Chairperson, ILGWU Local 525
3. ILGWU Health and Safety Department
4. Arkansas Department of Health
5. OSHA, Region VI
6. Requestors

For the purpose of informing affected employees, 42 CFR 85.11 requires the employer to post a copy of this report at or near the workplace(s) of affected employees for a period of 30 calendar days.